MOVITRAC® 31..
Frequency Inverters

Manual
FRS 31 Synchronous Operation Control

Edition 10/98

08/198/96

SEW
EURODRIVE

This manual contains all specific technical data and operating instructions for the FRS 31 Synchronous Operation Control package.

Apart from that, the general information about the MOVITRAC®31 series applies as included in the MOVITRAC®31 Operating Instructions.

Each unit is manufactured and tested to current SEW-EURODRIVE technical standards and specifications. The manufacturer reserves the right to make changes to the technical data and designs, which are in the interest of technical progress.

A requirement of fault-free operation and fulfilment of any rights to claim under guarantee is that these instructions and notes are followed.

This manual contain important information for servicing and should be kept near the unit.

- **This manual does not replace the detailed MOVITRAC® 31 Operating Instructions!**
- **Equipment may only be installed by qualified electrical personnel in compliance with the applicable accident prevention regulations and the operating instructions!**
- **When the unit's protective cover is removed, the MOVITRAC® 31 unit has enclosure IP 00. Dangerous voltages are present on some parts.**
  In normal operation the unit must be closed with the protective cover properly mounted!

Page

Modifications to the previous version, edition 02/97:
• Synchronous operation has been expanded with Mode 8.
  The manual now contains a description of Mode 8.

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1   Introduction

1.1   Description

The synchronous operation function enables a group of asynchronous motors (master and slaves) to maintain angular synchronism to one another or at a specified proportional ratio.

The synchronous operation function has 8 modes to cover a range of applications:

Modes	Functions	Application Examples
1	Free-running operation (for limited period) using terminal 102 with slave counter (P 765) and differential counter disabled.	Synchronous drives (conveyor belts, travel drives, hoist drives on multi-column hoists).
2	Free-running operation (for limited period) using terminal 102. "1" signal on term. 102 initiates free-running, "0" signal on term. 102 initiates synchronous operation; the angular difference between slave and master, which occurred during free-running is reduced to zero again, i.e. synchronous operation of slave with previous position in relation to master.	Synchronous drives with intermittent offset; free-running can be externally controlled in all phases.
3	Free-running operation (for limited period) using terminal 102. "1" signal on term. 102 initiates free-running, "0" signal on term. 102 initiates synchronous operation; slave receives new reference point in relation to master (value of P 765[1]).	Flying saws; free-running can be externally controlled in all phases.
4	Free-running operation (limited by value of P 765). "1" signal (pulse duration > 100 ms) initiates start of restricted free-running operation. When the angular difference between slave and master is the same as the value of P 765, free-running terminates and the angular difference is reduced to zero, i.e. synchronous operation of slave with previous position in relation to master.	As mode 2, though returns automatically to synchronous operation.
5	Free-running operation (limited by value of P 765[1]). "1" signal (pulse duration > 100 ms) initiates start of restricted free-running operation. When the angular difference between slave and master is the same as the value of P 7651), free-running terminates automatically. The angular difference is used as the new reference point of the slave to the master, i.e. synchronous operation of slave with new reference point (value of P 765[1]) in relation to master.	As mode 3, though returns automatically to synchronous operation.
6	Synchronous operation with intermittent angular offset; possible via terminals 103-105 [2].	Creation of deliberate unbalance/ friction in synchronized shafts
7	Synchronous operation with constant angular offset (phase trimming); possible via terminals 103-105 [2]	As mode 1, though with option of gradual position adjustment.
8	Free-running operation (for limited period) using terminal 102. "1" signal on term. 102 initiates free-running operation. "0" signal on term. 102 initiates synchronous operation; the internal counter for the angular difference is set to zero with the "1" → "0" edge and a new reference point is defined at the same time for synchronous operation. The slave receives a value of P765 (slave counter) as its new reference point.	Conveyor systems on which the goods to be conveyed are fed onto and off the system at regular intervals, e.g. docking roller conveyors.

1) The value of P 765 can be modified from the menu using the "teach-in" procedure.
2) Continuous signal (t ≥ 3 s) causes repeated angular offset with 4 angles per second

The principle behind synchronous operation is the continuous comparison of the angular position between the slave motor and the master. For this purpose, the master and slave motors should be fitted with encoders (pulse encoders) that output the same number of pulses. A MOVITRAC®31.. with the FRS 31.. option is used as the slave drive. The FRS 31.. option comprises the FEN 31.. Speed Detection Option and the FES 31.. Synchronous Operation Option. Synchronous operation of master and slave requires that the slave be fitted with a braking resistor. The master can, in some cases, require a braking resistor for regenerative operation.

The FES 31.. Synchronous Operation Option is installed in the MOVITRAC®31... at connector X20. This prevents connector X20 from being used for any other option. Parameter set 1 is the only set of parameters that can be used for both synchronous operation and speed control.

The master drive can be operated either with a MOVITRAC® 31.. in V/f mode or under speed control or, without a frequency inverter, directly from the mains. If supplied directly from the mains, the encoder of the master drive must have its own external voltage supply. If the signal "zero speed" is used in conjunction with open-circuit monitoring in the case of MOVITRAC®31.. operation, the master must also be fitted with the FEN 31.. Speed Detection option and have speed control activated.

Note:

We suggest that the maximum frequency (P202) of the slave drive be set higher than that of the master drive (at least 10 Hz).

An internal counter in the slave counts the differences in pulses compared with the master, i.e. the difference in the angular position of the master and slave.

This counter is evaluated differently depending on the mode of operation (P 764):

- **In synchronous operation** (= all modes 1-8) the internal counter is used to correct the angular offset to $\Delta\alpha = 0$.
- The internal counter is disabled when the slave is **free-running (mode 1)**.
- **In limited free-running mode**, the internal counter records the required pulse difference and processes it according to the mode of operation selected:
  in modes 2/4: free-running for a limited period, then return to previous angular position relative to the master,
  in modes 3/5/8: free-running for a limited period, then use new angular position relative to the master.
- In **synchronous operation with angular offset**, the internal counter corrects a variable angular offset $\Delta\alpha$ = the offset between master and slave:
  in mode 6: angular offset for a limited period, then return to previous angular position relative to the master,
  in mode 7: continuous angular offset (phase trimming)

1.2   Application Examples
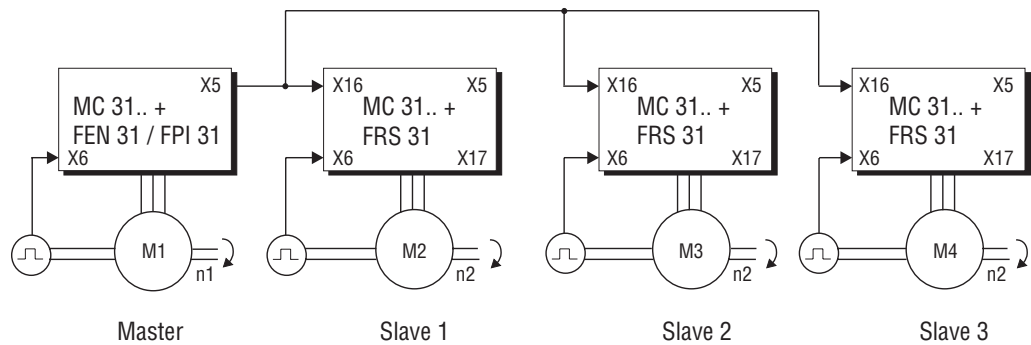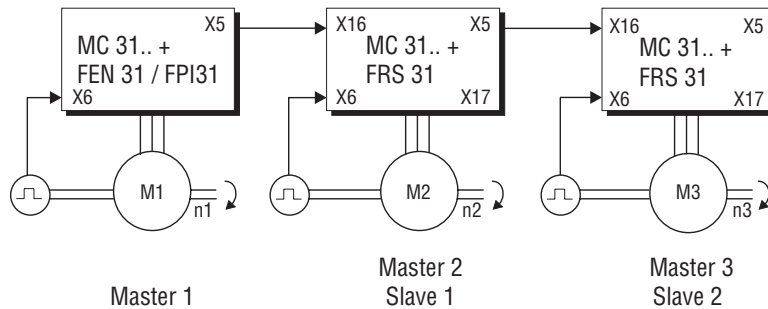

Figure 1:
Group configuration:
Master and several equal-priority slaves.
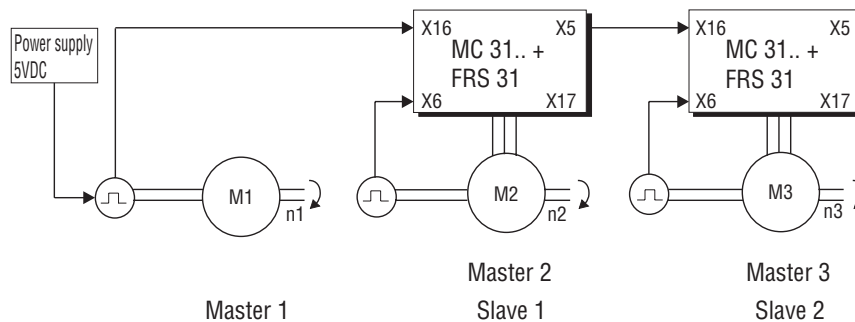Up to 10 slaves (max.) connected to one master
(e.g. for multi-column hoists, travel drives for gantry cranes, belt drives).

Figure 2:
Master-slave chain
(e.g. calendar drives, bottle washing machines)

Figure 3:
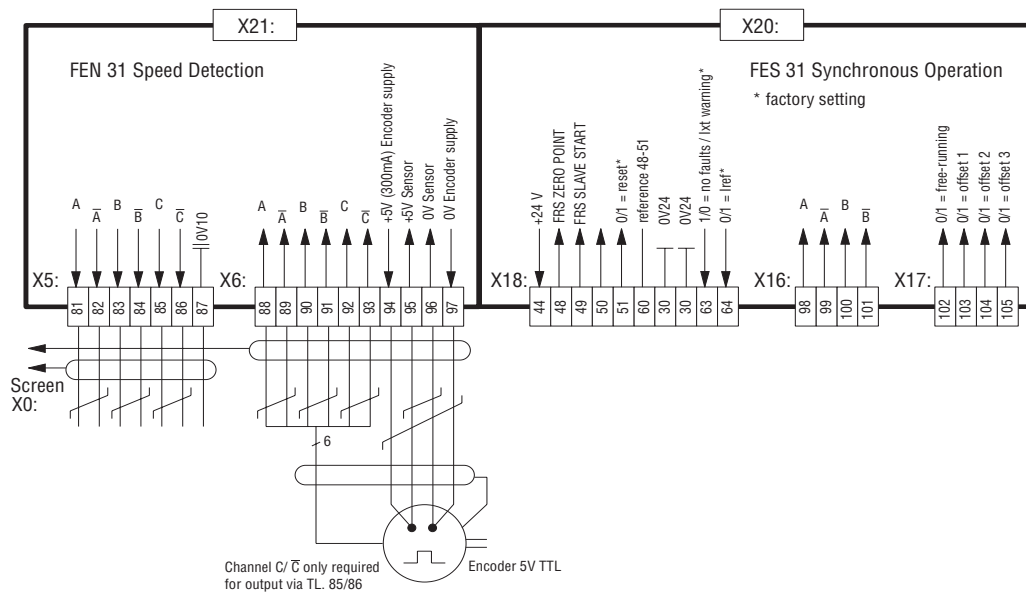Master-slave chain,
power for encoder supplied by M 1 external.

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Fig. 1: Application Examples

2 Wiring Diagram

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Fig. 2: FEN 31 and FES 31 wiring diagram

		FEN 31 Speed Detection Operation	
X5	81	Output: channel A	Setpoint pulses for slave
	82	Output: channel $\overline{A}$	
	83	Output: channel B	(5 V - TTL, RS-422)
	84	Output: channel $\overline{B}$	
	85	Output: channel C	not required for slave(s)
	86	Output: channel $\overline{C}$	
	87	Reference potential for terminals	
X6	88	Input: channel A	Connecting encoder
	89	Input: channel $\overline{A}$	The A → B channel sequence means:
	90	Input: channel B	motor runs clockwise
	91	Input: channel $\overline{B}$	(as seen from motor output shaft end),
	92	Input: channel C	i. e. channel A leads channel B when the fan
	93	Input: channel $\overline{C}$	rotates counter-clockwise
	94	Encoder power supply (+ 5...8 V)	For measuring voltage on encoder (if sensor leads
	95	Sensor line (+ 5 V)	are not connected, then leave TLs 95 and 96 open)
	96	Reference potential of terminal 95	
	97	Reference potential of terminal 94	
		FES 31 Synchronous Operation Option	
X18	44	+ 24 V	
	48	**Binary inputs (optically isolated)**	
	49	If there is a "1" on terminal 50, parameter set 2 is used and synchronous operation is disabled	
	50	R_i = 3.0 kΩ (DIN 19240) + 13 to + 33 V ≙ "1" = contact closed	
	51	-3 to + 7 V ≙ "0" contact open (can be allocated as required; signal types → P 60_)	
	60	**Reference potential** for terminals 48/49/50/51	
	30	**Reference potential** 24 V	
	63	**Binary outputs**	
	64	R_i = 100 kΩ	
		Max. current loading I_{max} = 50 mA, driver for max. 5 binary inputs (assignable; signal types → P 61_)	
X16:	98	Input from master: channel A	
	99	Input from master: channel $\overline{A}$	
	100	Input from master: channel B	
	101	Input from master: channel $\overline{B}$	
X17:	102	"1" = Free-running (+ 24 V) "0" = synchronous operation	
	103	"1" = Offset 1 (+ 24 V) "0" = without angular offset	
	104	"1" = Offset 2 (+ 24 V) "0" = without angular offset	
	105	"1" = Offset 3 (+ 24 V) "0" = without angular offset	

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3   Commissioning

3.1   Before you start

Master and slave drives must first be commissioned as stand-alone drives in V/f mode, then for speed control and then, as third step, for synchronous operation:

1. **Commissioning** for **V/f mode** of each master and slave drive (see MOVITRAC® 31.. Operating Instructions).
2. **Commissioning for speed control** of each slave drive; and of master, if this is not only to be used in V/f mode (see MOVITRAC® 31.. Operating Instructions).
3. The slave drives can then be set up for **synchronous operation** (see section 4 'Commissioning' and section 5 'Parameters').

Notes on project planning:

- If identical speeds of master and slave(s) are required when free-running, the internal fixed setpoints (n11/n12/n13/fmin) must be used instead of the external analogue setpoints.
- If similar drives are used in synchronous operation (e.g. multicolumn hoist), the most heavily loaded drive should be selected as the master.
- In a group configuration (1 master and x slaves on the same level) up to 5 units can be connected to 1 master binary output.

3.2   Wiring information

- The maximum permitted cable lengths are as follows:
  - between master and slave drive(s) (max. 10 slaves to 1 master): 8 m or 26.4 ft
  - between master or slave and associated incremental encoder: 150 m or 495 ft
- A cable break between master or slave drive and the associated incremental encoder is monitored by the unit itself as soon as the speed control function is activated (P 770 = speed control). When a fault occurs, the message "Error 11 speed measurement" is generated.
- A cable break between master and slave is monitored by the "cable break master - slave" function (on the slave: P 557 = Yes). This requires:
  - Connection from master: binary output "zero speed" (P 61x) to slave: binary input: "FRS CTRL" (P 60x). In the case of master-slave chain configurations, the slave must be connected to the master from which it receives its setpoint. If the setpoint cannot be sent from the master to slave or the master-slave connection is down, the message "Error 36 master slave connection" is generated.
  - Connection from slave: binary output "Fault" (default terminal 62) to master: binary input "Ext. error" (P 60x).
  - Connection of electronic reference potential (terminal 30) from the master to the slave(s). Master fitted with FEN 31 Speed Detection and Speed Control activated (P 770 = Yes).
  - Use of incremental encoders with 512/1024 or 2048 pulses/revolution (P 773). Open-circuit monitoring is not suitable for encoders with 256 or less pulses.
- Enable command for synchronous operation on slave unit:terminal 43 = "1" (enable) and terminal 41 = "1" (CW) or terminal 42 = "1" (CCW).
  Note: The direction of rotation information provided by the setpoint pulses from master to slave determines the direction of rotation of the slave during synchronous operation.
- Synchronous operation with constant starts and stops:
 Lowest possible angular offset of the slave in relation to the master through:
  - Slave permanently enabled, i.e. terminal 43 = "1" and terminal 41 or 42 = "1".
  - Program a binary output on the master as "rotating field on" (P 61x).
  - Connection from master: binary output "rotating field on" to slave: binary input "FRS slave start" (P 60x).
  - Activate the "setpoint stop function" on the slave (P 180 = On).
  - Set the same premagnetisation time (P 326) on the master and slave (e.g. ≤ 100 ms).

- If master and slave drives are to have the same direction of rotation:
  CW rotation of master = CW rotation of slave
  then the connection sequence of the motor phases and the units channels must be identical.
- If master and slave are to have opposite directions of rotation (e.g. output shafts of geared motors with an even number of gear stages are opposite one another):
  CW rotation of master = CCW rotation of slave
  - Swap round setpoint channels from master to slave (swap terminals 98/99 and 100/101 on slave in pairs).

3.3   Wiring example
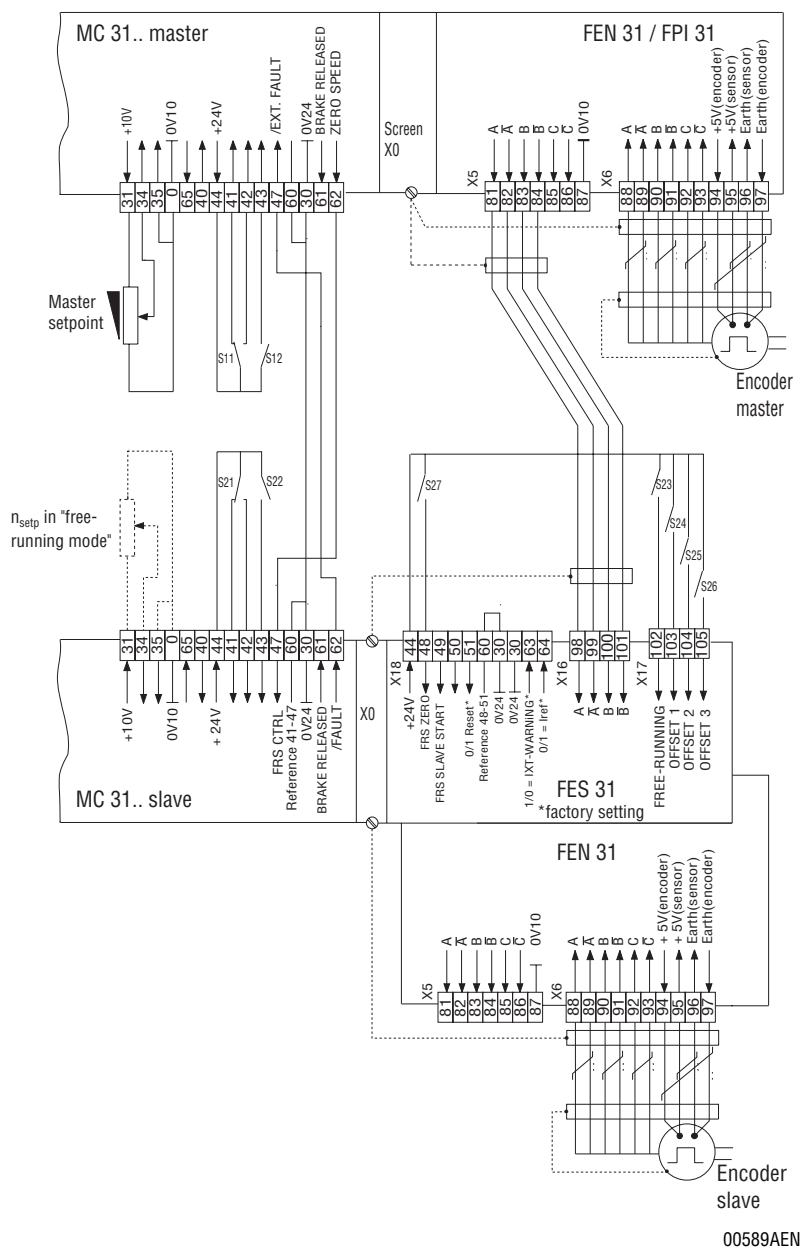
Notes:

- Differences to factory settings: Reprogram terminal 49 to "FRS SLAVE START" Reprogram terminal 50 to "NO FUNCTION"
- The terminals "EXT. ERROR", "FRS CTRL" and "FAULT" are active when low.
- To be able to stop the drive system from the slave as well, a binary output on the slave ("FAULT") must be connected to a binary input on the master ("EXT.ERROR"). If several slaves are present, the output relays on all slaves must be connected in series to the binary outputs and connected to the "EXT. ERROR" binary input on the master.
- S27 = "1" (closed) initiates a "SET ZERO", i.e. the internal differential counter is set to zero.

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Fig. 3: Wiring example – synchronous operation

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4   Parameters

4.1   Relationship between parameter values and output speed

In the case of the adjustable parameters (P 550, P 551, P 554, P 555, P 765, P 766/767/768), counter values relating to an angular offset (e.g. as permitted deviation or as offset) between master and slave drive are to be entered. They relate to the value that the inverter calculates based on the encoder pulses. **Encoder pulses are multiplied fourfold** in the inverter.

The counter value entered for the parameters is calculated from the angular offset of the motor according to the following formula, where the angular offset of the motor bears a relationship to motor revolutions (e.g. 180° = 0.5 revolutions).

Entered counter value Z = motor revolutions • 4 • number of encoder pulses

Example:

If the message "FRS LAG ERROR" is to be output whenever there is a deviation of 5 revolutions between master and slave and the encoders being used generate 1024 pulses/revolution, the value to be entered as P 551 is:

Entered counter value Z = 5 • 4 • 1024 = 20,480

This value can also be applied to the gear unit output shaft:

Motor revolutions = revolutions of gear output shaft • $i_{gear\ unit}$

If, in addition to the speed of the motor and the gear ratio, the input transmission also has an impact on the effective output speed of the machine, the number of motor revolutions should be calculated as follows:

Motor revolutions = Revolutions of output shaft • I_{gear} • $f_{input\ transmission}$

4.2   Signal functions

The following operating states occur:

- Visual signal on LED V11 (green) "MASTER-SLAVE DIFFERENCE" (P 555).
  LED V11 can be used during commissioning to indicate the maximum difference between master and slave:
  ON = angular difference > value of P 555 / OFF = angular difference < value of P 555
- Visual signal indicating the mode of operation on LED V12 (red) "SLAVE FREE-RUNNING":
  ON = Slave is free-running / OFF = Slave is in synchronous mode
- Status message "ZERO SPEED"
  – on one of the programmable binary outputs, terminals 62/63/64 (P 610 ff)
- Status message "SLAVE IN POS." (P 554)
  – on one of the programmable binary outputs, terminals 62/63/64 (P 610 ff)
- Signal "FRS ALERT SIGNAL" (P 550)
  – on one of the programmable binary outputs, terminals 62/63/64 (P 610 ff)
- Error message "FRS LAG ERROR" (P 551)
  – on one of the programmable binary outputs, terminals 62/63/64 (P 610 ff)
  – with the required response of the drive to a fault (P 553 - 0/1 signal / coast to rest / stop / rapid stop)

The MOVITRAC®31.. with the FRS 31 option has the following additional synchronous operation parameters. The **synchronous operation parameters** need only be entered **on the slave**; the master operates in V/f mode or as under speed control.

(Refer to the MOVITRAC®31.. Operating Instructions for the parameters for the basic unit).

Parameter address	Function	Value range (Factory setting)	Wiring examples
55	**Synchronous operation indications** *(with FRS 31 only)*		
550	FRS alert signal	**50**...99.999.999	
551	FRS lag error	100...**4000**...99.999.999	
552	Hold time	**1**...99 s	
553	Error response	**0/1 signal** / coast to rest / stop rapid stop	
554	Positional tolerance of slave	10...**25**...32768	
555	LED counter V11	10...**100**...32768	
556	Time constant position signal	5...**10**...2000 ms	
557	Cable break master-slave	**J** / N	
600–606	Binary inputs terminals 42/43/47/48/49/50/51	Also available for FRS FRS CTRL FRS slave start FRS teach-in FRS set zero	Set on slave: Term. 47 - FRS CTRL Term. 48 - FRS ZERO POINT Term. 49 - FRS SLAVE START Set on master: Term. 47 - Ext. fault
610–613	Binary outputs, terminals 62/63/64	Zero speed FRS alert signal FRS lag error Slave in position	Set on slave: Term. 62 – Fault Set on master: Term. 62 – zero speed
76	**Synchronous operation** *(with FRS 31 only)*		
760	Synchronous operation	Yes / **No**	
761	MOVITRAC is	**Master** / Slave	
762	Gear ratio factor – master	**1**...3,999,999,999	
763	Gear ratio factor – slave	**1**...3,999,999,999	
764	MODE	**1** / 2 / 3 / 4 / 5 / 6 / 7 / 8	
765	Slave counter	± (**10**...99999999)	
766	Offset 1	± (**10**...32767)	
767	Offset 2	± (**10**...32767)	
768	Offset 3	± (**10**...32767)	
769	Controller KP factor	1...**10**...200	

If the FRS 31 is being used, it will not be possible to activate the following functions:
- P 350 Parameter selection
  Switching parameter sets disables synchronous operation and speed control
- P 880 Master-Slave mode (terminals 67/68), i.e. frequency-proportional master-slave function via RS-485 serial interface of the MOVITRAC®31.. basic unit without an FRS 31 option package.

It is advisable to record the parameter settings:
- on a PC or
- by hand in the "Parameter table"
  (MOVITRAC® 31.. Operating Instructions, Parameter List)

MOVITRAC ® 31.. – FRS 31

4.3   Explanation of the parameters   to set up the slave

P 55   **Synchronous operation indications**

(with FRS 31 option package only)

Note on P 550, P 551 and P 554:

The numerical values for positional tolerance (P 554), alert signal (P 550) and lag error (P 551) must be entered in ascending order of significance, i.e.:

Position tolerance ≤ FRS alert signal ≤ FRS lag error

P 550   **FRS alert signal**   *Value range = 50...99.999.999*

An alert signal is issued if the angular offset exceeds the value entered here, irrespective of the mode of operation of the slave drive.

This signal can be used, for example, as a position signal and can be programmed as a signal output

• on one of the three binary outputs, terminals 62/63/64 (P 611/612/613)

P 551   **FRS lag error**   *Value range = 100...4000...99.999.999*

A lag error message is issued if the angular offset exceeds the value entered here, irrespective of whether the slave is in synchronous or free-running mode.

This error message can be programmed as a signal output

• on one of the three binary outputs, terminals 62/63/64 (P 611/612/613).

In addition to this 0/1 signal, the response of the inverter can also be programmed (P 553).

The signals are active when low. In modes 3, 5 and 8 the point of synchronization will already be the new cutting position when the free-running terminal is actuated. The "FRS alert signal" and "FRS lag error" messages therefore already apply to this point, so can be used for time-optimized positioning of the saws in a "Flying Saws" application. In modes 6 and 7, the synchronization point, after activating an offset terminal, resides in the new angular position. The messages "FRS pre-warning" and "FRS lag error" refer to the new position.

P 552   **Hold time**   *Value range = 1...99 sec.*

During the transition from free-running to synchronous operation or the offset mode the fault response (P 553) can be suppressed for a specified time (except 0/1 signal).

P 553   **Fault response**   *0/1 signal, coast, stop, rapid stop*

Setting:	Response of drive:
a) 0/1 signal	"0" signal on binary output (if programmed via P 610-613). Drive continues to run
b) Coast	"Lag error" message; Drive coasts to rest, output on terminal 61 "brake" stays high
c) Stop	"Lag error" message. Drive stops with ramp generator t11/12, output on terminal 61 "brake" goes low
d) Rapid	"Lag error" message. Drive stops with ramp generator t13, output on terminal 61 stop "brake" goes low

P 554   **Positional tolerance of slave**   *Value range = 10...25...32,768*

Various requirements must be satisfied to ensure **accurate positioning of the slave**.

The brake on the slave drive is applied when **all the following conditions** are satisfied:

- setpoint stop function **P 180 = "Yes"** activated
- the master is stationary
- the **master** is current free (no premagnetization, no hold control, no residual magnetization, no resistance measurement (SxR), no rapid start magnetization, no DC injection braking and no heating current)
- the **slave is stationary** and in the **position window**
  This signal can be used, for example, as a position signal and can be programmed as a signal output
  – on one of the three binary outputs, terminals 62/63/64 (P 611/612/613).)

P 555   **LED counter**   *Value range = 10...100...32,768*

The "MASTER-SLAVE DIFFERENCE" LED V11 (green) lights up if the angular offset exceeds the value entered here. This enables the actual maximum angular difference between master and slave to be indicated. This is particularly helpful during commissioning.

ON = angular difference > value of P 555 / OFF = angular difference < value of P 555

P 556   **Time constant position signal**   *Value range = 5...10...2,000 ms*

The "slave in position" binary output signal is not issued until the master and slave have remained within the positional tolerance P 554 for the time specified in P 556.

P 557   **Cable break master-slave**   *Yes / No*

Monitoring of the setpoint line between the master and the slave uses the connection between the binary output "zero speed" on the master and the binary input "FRS CTRL" on the slave as a reference signal. If "zero speed" = 0 and the FES 31 pcb is not receiving any setpoint input, the unit assumes a cable break on the setpoint line or the line between "zero speed" and "FRS CTRL". It then issues error message 36 "master slave connection".

For "open-circuit monitoring", the MOVITRAC® 31.. of the master must be fitted with the FEN 31 "Speed Detection" option. Speed control must be activated.

Note: Set P 557 = "No" if: - master motors with no inverter or
                       - encoders with < 512 increments/revolution (P 773)
                      (open-circuit monitoring is not possible in all modes of operation)

P 600 … 606   **Binary inputs**

The programmable binary inputs on terminals 42/43/47/48/49/50/51 can be allocated four additional signal types for synchronous operation.

- The internal counter for the angular offset can be set to zero with **"FRS set zero"**.
  "1" signal = present angular difference will be cleared.
  "1" → "0" = new reference point for synchronous operation. If this function is only required during commissioning, the binary input can subsequently be reassigned; this will be necessary if the master and slave need to be lined up with one another.
- The terminal to which **"FRS CTRL"** is assigned is connected to the "zero speed" binary output on the master. This is for open-circuit monitoring purposes (P 557).

- The terminal to which **"FRS slave start"** is assigned controls the synchronous start-up of master and slave if:
  - the inputs from the master's binary outputs with the function "rotating field on" receive a signal and
  - the setpoint/stop function (P 180) at master and slave become active.
- The terminal to which **"FRS Teach-in"** is assigned enables cut lengths (P 765) for the **"Flying Saws"** application to be entered. This can be implemented using modes 3 and 5. The input of cut lengths through a binary signal provides a solution in cases where the inverter cannot be accessed by the user.
  To enter cut lengths, the following actions are necessary:
  - the binary input assigned "FRS teach-in" must have a "0" signal
  - switch drive to free-running via terminal 102
  - length entered will be determined by reference points 1 and 2
  - approach reference point 1
  - switch "FRS teach-in" terminal to "1"
  - approach reference point 2
  - switch "FRS teach-in" terminal to "0"
  - switch drive to synchronous operation (terminal 102 = "0")
  - value entered for P 765 is no longer valid and is indicated by an asterisk
  -
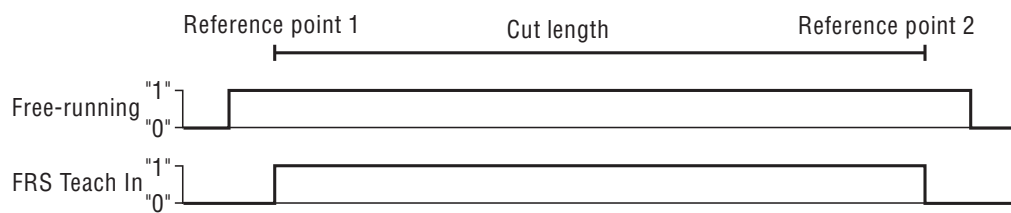
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Fig. 4: FRS teach function

The drive synchronizes itself afterwards to reference point 2.

Notes on approaching the reference points:

a) approaching the reference points by saw carriage:
   is recommended if the lengths to be cut are short. The material to be cut is halted and the saws travel the length to be cut.

b) approaching the reference point by the material to be cut:
   is recommended when the cut lengths are greater than the area in which the sawing operation is taking place. Set the first reference point to the present cutting position after cutting the material and halt the saw; start material feed and traverse the material by the required cut length and set the second reference point.

P 611 to 617   **Binary outputs**

The programmable binary outputs on terminals 62/63/64 can be allocated the following signals in addition to the usual signal types:

- "FRS alert signal" (see P 550)   active low
- "FRS lag error" (see P 551)   active low
- "Slave in position" (see P 554 and P 556) active high
- "Zero speed"   active high

P 760   **Synchronous Operation** *Yes / No*   *(only with FRS 31A option package)*

Setting (when unit disabled):

- on slave with FRS 31 option package:
  set synchronous operation = "YES"

- on master with FEN 31 option pcb:
  synchronous operation = "NO" and speed control (P 770) = "NO":   normal V/f mode
  synchronous operation = "NO" and speed control (P 770) = "YES":   speed control mode

P 761   **MOVITRAC® is master/slave**

TThis parameter determines the role of the appropriate unit/drive. Terminals 98 to 101 of the unit defined as the "SLAVE" must receive pulses from the pulse output on terminals 81 to 84 of the master. The appropriate wiring must be taken into account (see terminal connection diagram and application examples). Setting a unit as the "SLAVE" will automatically activate speed control (P 770).

P 762   **Gear ratio factor master**   *Value range = 1...3.999.999.999*

P 763   **Gear ratio factor slave**

These two parameters determine the angular velocity ratio of the slave to the master.

The following factors for master and slave drives must be taken into account during the calculation:

- exact gear ratios. To just two decimal places in the SEW catalog.
- input transmission ratios
- pulley diameter (including twice the belt thickness)

The **ratio between P 763 / P 762** is therefore calculated as:

$$\frac{P\ 763}{P\ 762} = \frac{(i_{gear} \bullet i_{input\ transmission})\ slave \bullet pulley\ diam_{master}}{(i_{gear} \bullet i_{input\ transmission})\ slave \bullet pulley\ diam_{slave}}$$

- In cases of the **same type of synchronized drives** with identical gear ratios (including input transmission), the value of both parameters will be "1".
- If the ratio between P 762 and P 763 **with the same type of drive** is # 1, proportional operation with an appropriate ratio can be selected. Examples:
  P 763 = 101 / P 762 = 100 → slave drive runs 1.01 times faster than the master.
  P 763 = 5 / P 762 = 10 → slave drive runs half as fast as the master.
  P 763 = 4444 / P 762 = 2000 → slave drive runs at 2.222 times the speed of the master.
- Where the **drives are of different types** (example: main drive and feed drive for flying saws), the desired angular velocity ratio can be specified.

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P 764   **Selection of mode**   *Value range 1...8*

The selected mode determines how the slave reacts to a free-running signal.

"0" signal on terminal 102 or terminals 103-105, i.e. constant corrective control of synchronous operation means counter value $\Delta\alpha = 0$, i.e. no angular offset between master and slave.

In free-running mode (terminal 102 = "1"), the external setpoint n2 (terminals 34/35) or the internal setpoints n11/12/13 will be activ.

Mode	Mode of operation	Description	Command		Status (P765) slave counter	LED V12 (red)
			Status TL 102	Status TL 103-105		
1	Free-running – unrestricted	Slave counter (P 765) inactive /differential counter inactive	"1"	Inactive	Inactive	ON
2	Free-running – limited perioddetermined by term. 102	"1" signal initiates free-running. When "1" signal removed, slave reduces the angular difference to zero, i.e. synchronous operation in previous position relative to master	"1"	Inactive	Inactive	ON
3	Free-running – limited perioddetermined by term. 102 – with new reference point	"1" signal initiates free-running. When "1" signal removed, slave goes to the value of P 765. Slave thus has a new reference point relative to the master	"1"	Inactive	active	ON
4	Free-running - limited by value of P 765	"1" signal (pulse duration > 100ms) initiates start of limited free-running. Free-running ends when value of P765 reached. Slave then reduces the angular difference to zero, i.e. synchronous operation in previous position relative to master	"1"	Inactive	active	ON
5	Free-running – limited by value of (P 765) – with new reference point	"1" signal (pulse duration > 100 ms) initiates start of limited free-running.Free-running ends when value of P765 reached. Slave then switches to synchronous operation with this new value and thus has a new reference point relative to the master. The sign of P765 determines if the new reference point preceeds or follows the direction of rotation, in respect to the new master position.	"1"	Inactive	active	ON
6	Synchronous operation – with intermittent angular offset	Slave runs with offset (angular offset to master) Value of P 766	"1"	TL. 103 = "1"	Inactive	ON
		Slave runs with offset (angular offset to master) Value of P 767	"1"	TL. 104 = "1"		
		Slave runs with offset (angular offset to master) Value of P 768	"1"	TL. 105 = "1"		
7	Synchronous operation – with constant angular offset (phase trimming)	Slave runs with offset (angular offset to master) Value of P 766	"1"	TL. 103 = "1"[1]	Inactive	ON
		Slave runs with offset (angular offset to master) Value of P 767	"1"	TL. 104 = "1"[1]		
		Slave runs with offset (angular offset to master) Value of P 768	"1"	TL. 105 = "1" [1]		
8	Free-running – limited period determined by term. 102 – with new reference point	"1" signal initiates Free-running. Removal of the "1" signal sets the internal counter for the angular offset to zero and a new reference point is defined at the same time. The value of P765 (slave - counter) is the new reference point	"1"	Inactive	active	ON

1) If the terminal has a signal of "1" for more than 3 seconds, the slave readjusts itself continuously 4 times per second.

P 765   **Slave counter** (differential value)

Value range = –99,999,999...10...99,999,999

The slave counter is entered with a sign. It is an adjustable angular offset that, depending on the mode, is interpreted as either a limit for free-running operation or specifies a constant angular offset for the slave, i.e. a new reference point relative to the master.

In **mode 3**, the "Slave counter" parameter specifies a new reference point relative to the master for the slave to adopt when free-running terminates. In the case of a positive value, the new reference point will lie in a positive direction of rotation relative to the master, and in a negative direction of rotation relative to the master if the value is negative.

In **mode 4**, the slave counter is used as a limit value and is interpreted as an absolute number. When the slave reaches the difference in pulses specified (angular difference) in free-running mode, it returns automatically to its old position relative to the master. This occurs regardless of whether the slave is ahead of the master in free-running mode (because of a higher setpoint value) or whether it is lagging behind (smaller setpoint).

In **mode 5**, the "Slave counter" parameter specifies, as with mode 3, a new reference point for the slave relative to the master. In the case of a positive value, the new reference point will lie in a positive direction of rotation relative to the master, and in a negative direction of rotation relative to the master if the value is negative. The slave resynchronizes itself automatically with the master when it reaches the new reference point. This assumes a suitable setpoint value when the slave is in free-running mode.

In **mode 8**, the "Slave counter" parameter, as with mode 3, specifies a new reference point for the slave relative to the master. Before the new reference point is set, the internal counter for the angular offset is set to zero.

The difference values are entered with a sign:

• Display value "-":   slave lags behind the master; the value is subtracted from the previous reference point.
                       = offset in lag direction of rotation
• Display value "+":   slave leads the master; the value is added to the previous reference point.
                       = offset in lead direction of rotation

P 766   **Offset 1**   term. 103   *Value range = –32.767...10...32.767*

P 767   **Offset 2**   term.104   (MODES 6 & 7)

P 768   **Offset 3**   term.105

Mode 6:

They represent 3 separate angular differences that the slave employs for the duration of the "1" signal on terminals 103 / 104 / 105. The offset values are mutually exclusive, i.e. if one is active, the others are disabled.

Mode 7:

As mode 6, though the angular offset remains even after the signal is removed. If the "1" signal is present for more than 3 seconds when in mode 7, the slave readjusts itself continuously 4 times per second.

Mode 6 and 7: Sign of angular values as with mode 5.

P 769   **Controller Kp factor**   *Value range = 1...10...200*
                                                             (Usual value range = 3...70)

The K_p factor enables the gain of a synchronous mode controller to be specified. It determines the slave control response depending on the angular difference to the master. The larger the value of K_p, the quicker any angular difference is made up, though the tendency to oscillate increases as well. This is to avoid unnecessary loading of the braking resistor.

K_P = (Value of P 769) • 0.022 rpm / 1°

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5   Fault Messages

The following fault messages can occur especially in Synchronous Operation.
For a complete list of faults refer to the MOVITRAC® 31.. Operating Instructions.

No.	FAULT MESSAGE	Switch-off mode	Reset	Cause
11	**SPEED DETECTION**	Immediate switch-off	●	Only with active speed control – FEN 31 option board not installed – Wrong option board installed – Cable break between TLs 94 or 97 and encoder
35	**FRS ENCODER CONNECTION**	Immediate switch-off	●	Power supply to incremental encoder – defective (switch-mode power supply) – interrupted (cable break)
36	**MASTER SLAVE CONNECTION**	Immediate switch-off	●	Cable break detected on master-slave line (if P 557 = "Yes") – setpoint connection to slave terminals 98-101 lost – reference signal from "zero speed" binary output on master → "FRS CTRL" binary input on slave lost – no input on slave has been assigned to "FRS CTRL" – no output on master has been assigned to "zero speed" – no master inverter present – encoder with < 512 pulses/revolution – speed control mode on master FRS PARAMETER DATA FAULT disabled
37	**FRS RAM FAULT**	Immediate switch-off	●	Internal fault. Contact SEW Service Dept. if fault persists
38	**FRS PROCESS DATA FAULT**	Immediate switch-off	●	Fault on interface between inverter and FES 31 option pcb: – fault induced by EMC Contact SEW Service Dept. if fault persists
39	**FRS PARAMETER DATA FAULT**	Rapid stop	●	Invalid value for FRS 31 parameter
41	**FRS LAG FAULT**	Programmable (P553)	●	Deviation between master and slave ≥ specified limit value for lag error (P 551)

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6 Technical Data

The FRS 31 option package consists of FEN 31 and FES 31 pcbs and installation material.
Part number 822 172 3

Option	TL. = terminal	FEN 31 Speed Measurement
Encoder power supply	**TL. 94 + /97 (reference)**	+ 5 V (up to V_{max} = 8 V / I_{max} = 300 mA)
Sensor control	**TL. 95 + /96 (reference)**	For voltage measurement and readjusting to 5 V on encoder input (if the sensor leads are not connected, then terminals 95 and 96 should be left open).
Pulse inputs A/$\overline{A}$, B/$\overline{B}$, C/$\overline{C}$	**TL. 88–93**	+ 5 V, TTL level (RS-422)
Pulse outputs A/$\overline{A}$, B/$\overline{B}$, C/$\overline{C}$	**TL. 81–86**	+ 5 V, TTL level (RS-422)
No. of encoder pulses per channel and revolution ($\rightarrow$ **P773**)		128/256/512/1024/2048 (preferred number of pulses per revolution: 1024)
Limit frequency of inputs	**TL. 88–93**	f_{limit} = 200 kHz
Limit speed in relation to f_{max}		at 2048 pulses: 6000 rpm at 1024: 12000 rpm

Option		FES 31 Synchronous Operation
Setpoint pulse inputs on slave (from master) A/$\overline{A}$, B/$\overline{B}$	**TL. 98–101**	+ 5 V, TTL level (RS-422)
Limit frequency of inputs		f_{limit} = 200 kHz
Maximum usable frequency	($\rightarrow$ **P202**)	f_{max} = 120 Hz
LED V11 (green): <u>zur Anzeige der Winkeldifferenz</u>		ON = angular difference > value of P555 OFF = angular difference < value of P555
LED V12 (red)		ON = slave is free-running OFF = slave is synchronous
Binary inputs		Isolated via opto-couplers, $R_j \approx$ 3 kΩ, sample time $\leq$ 5ms EN 61131-2) $I_E \approx$ 10 mA, PCL compatible
Voltage level		(+ 13...+30) V $\triangleq$ "1" = contact closed (-3...+5) V $\triangleq$ "0" = contact open
Control functions	**TL. 102** **TL. 103/104/105** **TL. 48/49/50/51**	for modes 1-8 "1" = free-running "0" = synchronous for modes 6/7 "1" = angular offset "0" = synchronous programmable binary inputs ($\rightarrow$ P60_) Signal types $\rightarrow$ MOVITRAC® 31C Operating Instructions, section 4.4; e.g. FRS CRTL/FRS Zero-point/FRS Slave Start/ FRS Teach-in
Binary outputs		$R_j \approx$ 100 kΩ, response time $\leq$ 5 ms, I_{max} = 50 mA
Voltage level		"0" $\triangleq$ 0 V, "1" $\triangleq$ 24 V, PCL compatible <u>**Important:**</u> Do not connect to external voltage source!
Voltage level	**TL. 63/64**	Programmable binary outputs ($\rightarrow$ P61_) Signal types $\rightarrow$ MOVITRAC® 31C Operating Instructions
Terminals		Separable; grid = 3.8 mm Suitable for wires with cross sections up to 0.75 mm^2
Service life of RAM battery	**Type**	Standard CR 2430 (25 ×3 mm) batteries, available from usual stockists; spare batteries not available from SEW. More than 10 years; dispose of used batteries legally.
Dimensions	**W × H × D**	80 ×160 ×20 mm

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